A *Superior* Research Reader

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Photo Credit: Steve Eggers; Ron Zalesny, US Forest Service; Menominee Tribal Enterprises

Greetings and welcome to A *Superio*r Research Reader, a monthly reader on what we believe is current and relevant research to science and resource management on the Superior.

This Month's Edition:

In line with last month's local research theme which highlighted research done by staff on the Forest, we'd like to feature research conducted *on* the Forest by our partners. In this issue you'll find what people are learning and how it relates to our management on the Forest. Biomass, climate change, and adaptive forestry techniques are a few of the topics covered. Plus, a bonus article from our neighbor, the Chip, about the dreaded Emerald Ash Borer. Enjoy this month's edition and we hope you are able to apply some of this cutting edge research that's happening on our Forest.

Happy reading,

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1. Abbas and Arnosti explore the economic and logistical factors of biomass utilization on trials in Superior National Forest.

2. Our friends at the Northern Institute of Applied Climate Science (NIACS) use information from the Superior and other case studies to provide a framework for climate change adaptation actions on the Forest.

3. Peter Reich and colleagues use data collected on our Forest to offer insights into which species will have a better chance of surviving at place where boreal and temperate forests intersect.

4. Researchers from NRS provide insights on how the Emerald Ash Borer, and the subsequent death of black ash trees, may affect our black ash stands on the Forest.

Economics and Logistics of Biomass Utilization in the Superior National Forest

Abbas and Arnosti, 2013. Journal of Sustainable Forestry

ABSTRACT: Forest fires pose a great risk to nearby communities and dwellings. Many forest managers work to reduce such risks by managing fuels. This article explains the economic and logistical factors of a forest biomass utilization option instead of the conventional disposal method of on-site piling and burning for fuel reduction. Benefits from biomass utilization are multiple and include reduced impacts to air quality, improved forest health, economic opportunities, local renewable energy production, and climate change mitigation. Trials in the Superior National Forest examined the feasibility of using conventional equipment to extract and utilize forest biomass compared with disposal of biomass with pile and burn techniques. Factors that increase the costs of biomass utilization include: machinery down-time, distance to end users, low biomass price, size of the harvest unit, forwarding distance, the number of machines hauled to sites to complete small-sized operations, the modest amount of biomass removed per acre and applying prescriptions that were not designed for extraction logistics. Interviews with forest machine operators during and after the trials helped clarify factors and logistics considerations, which could be applied to help reduce the cost of future operations.

A Practical Approach for Translating Climate Change Adaptation Principles into Forest Management Actions

Janowiak et al. 2014. Journal of Forestry

ABSTRACT: There is an ever-growing body of literature on forest management strategies for climate change adaptation; however, few frameworks have been presented for integrating these strategies with the real-world challenges of forest management. We have developed a structured approach for translating broad adaptation concepts into specific management actions and silvicultural practices for forest adaptation, as well as an associated set of resources to assist managers in using this approach. A variety of public, private, nongovernmental, and tribal natural resource managers are using this approach to develop projects that implement a diversity of adaptation actions while also meeting manager-identified goals. We describe how managers can integrate climate change information into management planning and activities and provide examples of real-world forest management projects that identify actions to help forests adapt to changing conditions.

Geographic range predicts photosynthetic and growth response to warming in co-occurring tree species

Reich et al. 2015. Nature Climate Change

ABSTRACT: Populations near the warm edge of species ranges may be particularly sensitive to climate change but lack of empirical data on responses to warming represents a key gap in understanding future range dynamics. Herein we document the impacts of experimental warming on the performance of 11 boreal and temperate forest species that co-occur at the ecotone between these biomes in North America. We measured *in situ* net photosynthetic carbon gain and growth of >4,100 juvenile trees from local seed sources exposed to a chamberless warming experiment that used infrared heat lamps and soil heating cables to elevate temperatures by +3.4 °C above- and belowground for three growing seasons across 48 plots at two sites. In these ecologically realistic field settings, species growing nearest their warm range limit exhibited reductions in net photosynthesis and growth, whereas species near their cold range limit responded positively to warming. Differences among species in their three-year growth responses to warming parallel their photosynthetic responses to warming, suggesting that leaf-level responses may scale to whole-plant performance. These responses are consistent with the hypothesis, from observational data and models, that warming will reduce the competitive ability of currently dominant southern boreal species compared with locally rarer co-occurring species that dominate warmer neighboring regions.

Sap flow of black ash in wetland forests of northern Minnesota, USA: Hydrologic implications of tree mortality due to emerald ash borer

Telander et al. 2015. Agricultural and Forest Meteorology

ABSTRACT: Black ash (*Fraxinus nigra*) mortality caused by the invasive emerald ash borer (EAB) is of concern to land managers in the upper Great Lakes region, given the large areas of ash-dominated forest and potential alteration of wetland hydrology following loss of this foundation tree species. The importance of changes in evapotranspiration (ET) following black ash mortality is currently unknown and is the focus of this study. Sap flux density rates were evaluated at three black ash stands with differing moisture regimes within the Chippewa National Forest, Minnesota, USA using the Granier thermal dissipation method. Sapwood area and sap flux density were combined to determine sap flow. Tree level sap flux density estimates were comparable to other reported values and averaged 4.59, 2.31, and 1.62 $m^3\ m^{-2}\ day^{-1}$, respectively, for the very wet, wet, and moderately wet field sites. However, black ash exhibited small sapwood area in general, resulting in lower overall sap flow values. Scaled stand-level transpiration followed a similar trend as the tree-level estimates; mean daily transpiration over 10 weeks was 1.62 (80% of PET), 1.15 (53% of PET), and 0.90 (42% of PET) mm for the very wet, wet, and moderately wet site, respectively. Sap flux density was positively related to vapor pressure deficit when soil moisture was at or near saturation and negatively related when soil moisture content was lower. There was also a significant positive relationship between sap flux density and relative soil moisture saturation at the stand scale. Our results indicate that hydrologic regime has substantial influence on sap flow with highest transpiration when soil moisture is at saturation, underscoring the unique ecological role that black ash plays in these wetland forest types. The effects of EAB-induced black ash mortality on overall ET and related hydrologic processes will likely be greatest in the wettest hydrologic regimes.